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E. W. LEHMANN, President — RAYMOND OLNEY, Secretary-Treasurer

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The Object and Scope of A. S. A. E. Activities

THE American Society of Agricultural Engineers was organized in December, 1907, at the University of Wisconsin by a group of instructors in agricultural engineering from several state agricultural colleges, who felt the need of an organization for the exchange of ideas and otherwise to promote the advancement of agricultural engineering. The object of the Society, as defined by the Constitution, is "to promote the art and science of engineering as applied to agriculture, the principal means of which shall be the holding of meetings for the presentation and discussion of professional papers and social intercourse, and the general dissemination of information by the publication and distribution of its papers, discussions, etc."

The membership of the Society represents all phases of agricultural engineering, including the educational, professional, industrial, and commercial fields.

The scope of the Society's activities embraces both the technical and economic phases of the application of engineering to agriculture, and is comprehended in the following general headings:

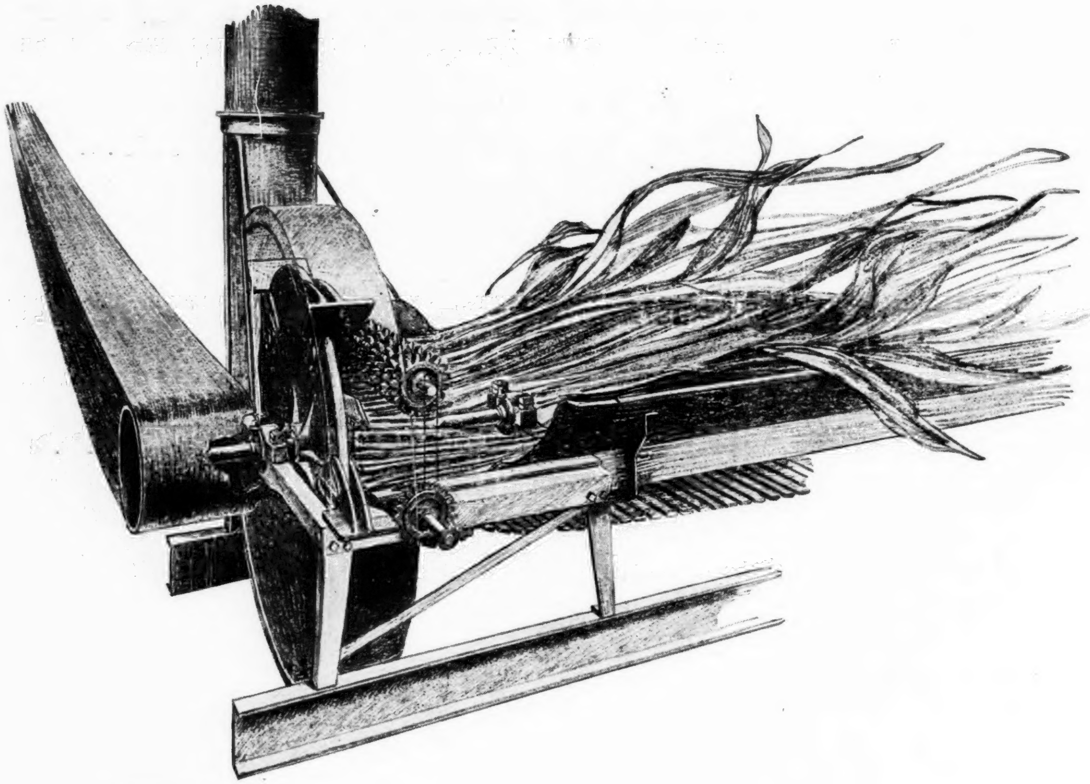
(a) Farm Power and Operating Equipment—power, implements, machines, and related equipment.

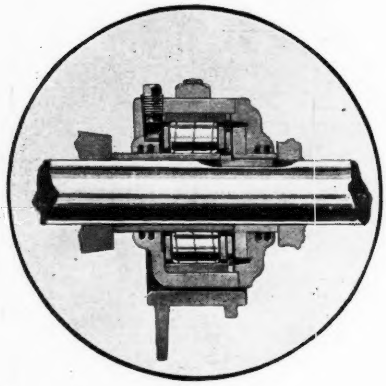
(b) Farm Structures—buildings and other structures and related equipment.

(c) Farm Sanitation—water supply; sewage disposal; lighting, heating, and ventilating of farm buildings, and related equipment.

(d) Land Reclamation—drainage, irrigation, land clearing, etc., and related structures and equipment.

(e) Educational—teaching, extension, and research methods, etc., employed in the agricultural engineering field.





AGRICULTURAL ENGINEERING

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Vol. 4 SEPTEMBER, 1923 No. 9

Some Factors in Scientific Dairy Barn Design*

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SANITATION in the dairy barn is of great importance in the production of clean milk. One factor in the maintenance of sanitary conditions in the barn is the disposal of the manure. From the standpoint of the health of the cows manure should be removed at least once a day to a distance of 50 feet or more from the barn, for temporary disposal, and then taken to the fields as soon as possible. The old practice in the New England states of disposing of manure beneath the stable floors should be discontinued as a sanitary measure, since it is not possible to keep the barn free from odors.

Economic removal of litter from the barn involves the use of labor-saving devices. This is a large subject in itself and cannot be fully discussed at this time, but it is of primary importance that the gutters be so designed that they may be easily cleaned.

Sizes of Cow Stalls

The accompanying table suggesting dimensions for cow stalls has been made after a careful study and the measurement of more than one hundred cows with observations made on nearly 1,000 cows in various states. Specific dimensions applicable to any particular breed can not be given, since there are great variations between individuals of each breed, but it is believed that the dimensions in the accompanying table are entirely practicable. Where a "tailor fit" stall is desired, the following rule may be used:

Measure the horizontal distance *L* (Fig. 1) from the point of the shoulder to the tailhead, and add to this dimension 6 inches. This gives the length from the stanchion line to the edge of the gutter.

Suggested Dimensions for Cow Stalls

Breed	Width W	Length, *L* Small	Medium	Large
Holstein	3'-6" to 4'-0"	4'-10"	5'- 2"	5'-8"
Shorthorn	3'-6" to 4'-0"	4'- 8"	5'- 0"	5'-6"
Ayrshire	3'-6" to 3'-8"	4'- 6"	5'- 0"	5'-6"
Guernsey	3'-4" to 3'-6"	4'- 6"	4'-10"	5'-4"
Jersey	3'-4" to 3'-6"	4'- 4"	4'- 8"	5'-0"
Heifers	2'-9" to 3'-2"	3'- 8"	3'-10"	4'-2"

Length of stalls, *S*, 3'-6" for cows; 3'-0" for heifers and young stock

Adjustable stanchion hangers have been used in order to vary the distance from stanchion to gutter. This method of adapting the stalls to the cows may be helpful after the stalls are built and there is no opportunity to change the construction. However, it has been observed that, in dairy barns, they are very seldom used properly and that many times the largest cow is placed in the stall with the shortest adjustment and the smallest cow in that having the longest adjustment. Fig. 2 shows a row of cows properly lined up on the gutter. These stalls were made of graded lengths with the longest stall on one end and the shortest on the other, and the cows were placed accordingly.

No stall less than 3 feet 4 inches in width should be used for cows in milk; even this width allows little room for milking and there is great likelihood of injury to the cow's udders. The average width of stalls in use is 3 feet 6 inches, which is an economical dimension. However, it is too narrow for many large Holstein cows, and it is better to use a stall 3 feet 8 inches, or 4 feet wide.

Sometimes a recess (Fig. 1) is made in the floor at the front of the stall. This recess tends to hold the bedding on

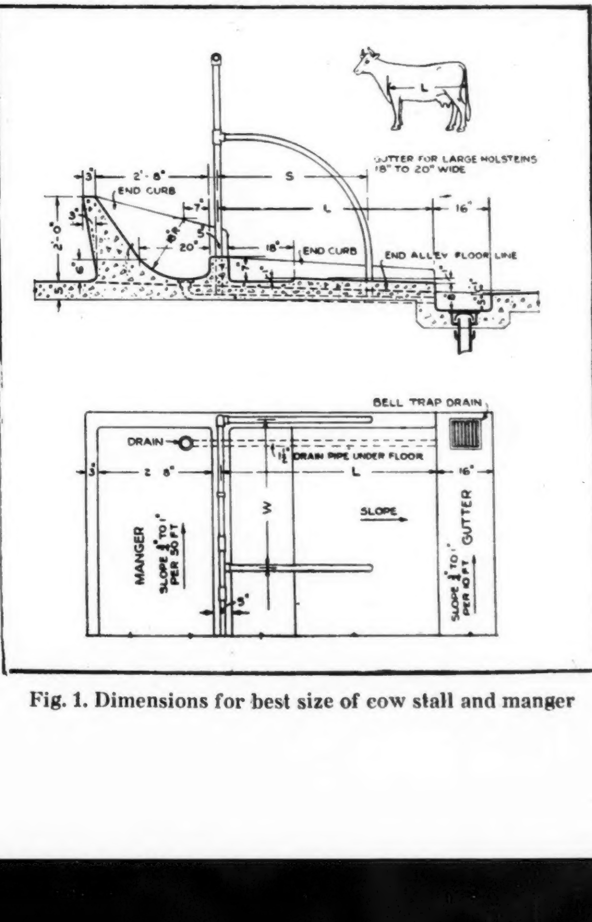

Fig. 1. Dimensions for best size of cow stall and manger

*1922 report of the Committee on Farm Building Equipment.

Fig. 2. Row of cows in stalls with varying lengths

the floor. Many specifications provide for a 16-inch recess which is too short. The length should be 18 inches measured from the curb, and for large cows 20 inches is better. When sawdust is used for bedding, the recess is made 1 to 1¾ inches deep, but when straw is available it is made ¾ to 1¼ inches deep. The offset at the rear of the recess should be rounded or sloped but not too much lest the purpose of the recess should be wholly or partially defeated.

Installation of Water Bowls

The use of water bowls in dairy barns has rapidly increased during the past few years. Farmers have learned of their convenience and advantages. The practice of watering cows in continuous mangers should be condemned; it is a very ready means of transmitting disease from one animal to another. There is no need of discussing the advantages of using water bowls as the subject is treated more fully in a previous report than is possible at this time.[1]

There seems to be little uniformity in the installation of water bowls and some users of this equipment have had trouble because of improper placing. This discussion relates to the principal difficulties and the means of overcoming them. It is not necessary to enlarge upon the importance of an abundance of pure water for dairy cows. It is well known that milk is approximately 87 per cent water and that a cow requires 8 gallons of water to produce 10 gallons of milk in addition to the water she needs to keep up her body processes. The total quantity of water required by a dairy cow is in proportion to the amount of milk given and the rate is about 2½ pounds of water for each pound of milk produced. It has been observed that after water bowls have been installed, that is, when cows have free access to water, they drink more in the evening than during the day, and that most of the water is consumed during the period of rumination.

There are two general types of water bowls used: the gravity system, which is little better than watering in the mangers, the principal advantage being the supply of water at all times; and the detachable automatic bowls. The latter type is preferred by most dairy farmers. Several different devices have been used for fastening the detachable water bowls. Some of these have been very satisfactory while others permitted the cows to knock the bowls loose without much effort. The fasteners should be so designed that the bowls will be substantially and firmly fixed yet easily removed by hand for cleaning.

There is little need for covers on detachable water bowls as they may be easily cleaned, and the latest designs do not have covers. It has been observed that in some barns equipped with covered water bowls, 20 per cent of the cows had sore noses and all had calouses. Sometimes the bowls are placed in front of the stanchion line, which is most convenient for the cows, while in other cases, because of interference with manger divisions, they are placed to the rear.

The improper placing of the water bowls has been the cause of annoyance and in some instances more serious trouble. The height at which the bowls should be fixed will vary somewhat with the breed of cows. Each line of water bowls should be graded from one to the other in order to drain the mains and make it possible to cut the riser pipes the same length. It has been observed in many barns that the bowls were placed too high making it difficult for the cows to drink, as they could not get their muzzles into the bowls and were forced to lap the water out. This is often the case when the bowls are placed more than 32 inches above the floor. When the bowls are placed too low, they are likely to become filled with feed and hay, and the cows are apt to form the habit of slopping the water out of the bowl, thus wetting the manger and stall floor. If the bowls are placed as low as 20 inches, which is by no means an uncommon height, it sometimes happens that a cow will place her foot upon the lever valve and flood the barn.

For Jersey cows and other small breeds the bowls should be placed from 26 to 28 inches high, while for Holsteins and the larger breeds they may be from 28 to 30 inches. Less dirt and feed will get into the bowls if they are placed at a good height, but they should not be placed so high as to make it difficult for the cow to drink.

Both underground and overhead systems of water mains are used. It is difficult to repair leaks in underground systems as the pipes are below the concrete floors. From this standpoint the overhead system is preferable, as the main water supply pipe is usually placed close to the ceiling with down pipes leading to the water bowls. Sometimes the main is placed above the top rail of the stalls and fastened to the rail by means of clamps, an arrangement which is to be recommended because of the better appearance and less amount of pipe required. It is necessary to use yokes over feed alleys and passageways in order to obtain head clearance. The yokes are not of much disadvantage and provide convenient places for faucets or plugs for the draining of pipe lines. In some sections it is often desirable to drain the pipes and shut off the main water supply during severe weather so that conveniences for draining are quite desirable. The temperature near the ceiling is usually from 3 to 4 degrees higher than that near the floor, therefore exposed pipes placed at the ceiling are less liable to freeze than those placed at a lower level. Pipe lines are sometimes installed behind the curb just above the floor. In this arrangement the pipes are more accessible in case of repairs but the collecting of dirt, shown in Fig. 4, is undesirable.

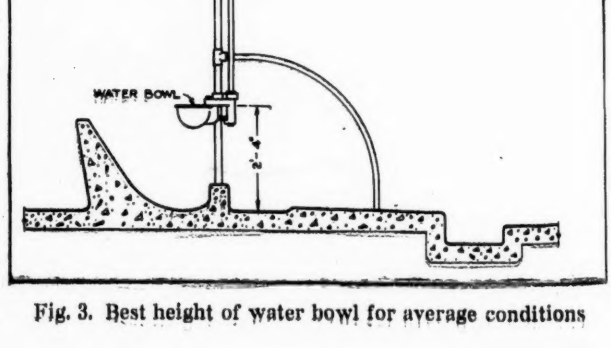

Fig. 3. Best height of water bowl for average conditions

[1]Transactions of the American Society of Agricultural Engineers, Vol. XII, 1918.

The pipe mains should be large enough to supply $2\frac{1}{2}$ to 3 gallons of water per minute, which is approximately the rate at which a cow drinks. The water bowls are usually tapped for $\frac{3}{4}$-inch pipe, and 1 to $1\frac{1}{2}$-inch pipes are used for mains depending upon the available water pressure. If the pressure is low a larger size is necessary. If the pressure in the water mains is above 20 pounds per square inch, a pressure-reducing valve should be used, as otherwise it will be difficult for the cows to operate the valves in the bowls.

Gutters in Dairy Barns

Many different types, shapes and sizes of gutters have been used in dairy barns. In some of the earlier barns in which the floors were of dirt, a continuous trench was dug behind the cows in order to concentrate the litter. Later these trenches were lined with planks in order to make them of a more permanent nature and for convenience in cleaning. The next step in advancement was the use of plank floors, which made it easier to keep the stalls and alleys clean. Then concrete was used in making still better sanitation and easier cleaning possible.

The selection of the type of gutter to be used in a dairy barn deserves more attention than is usually given it, since the design of the gutter has great influence upon the maintenance of sanitation in the barn and the amount of labor required to do the daily chores. The saving in labor resulting from the use of better gutter designs is appreciable even when the stable is cleaned but once a day, when the gutters are cleaned two or three times a day, the total saving may amount to considerable. A gutter should be safe, sanitary, durable and easily constructed. In order that the gutter may be safe it should not be so wide as to tempt the cow to jump over it in getting into the stall, or so deep as to make it difficult for the cow to get out of the stall. The gutter should not be much over 18 inches wide and 10 inches deep, nor should it be less than 6 inches in depth. The litter alley floor should be lower than the stall floor, as it is more difficult for the cow to back out of the stall when the alley floor is of the same level. Gutter surfaces should be made smooth for ease in cleaning, but not slippery. The alley floors should not be made smooth but should be finished with carpet or cork float. This is a precaution which is sometimes overlooked, and as a consequence the floors have to be roughened by the expensive use of the pick axe or the cold chisel.

In order that the gutters may be easily cleaned they should have smooth surfaces with as few corners as possible and no cracks or crevices to hold dirt. Gutters should be made watertight so that all liquid manure may be saved and to prevent absorption of liquids which will result in bad odors. It is good practice to sprinkle lime in the gutters

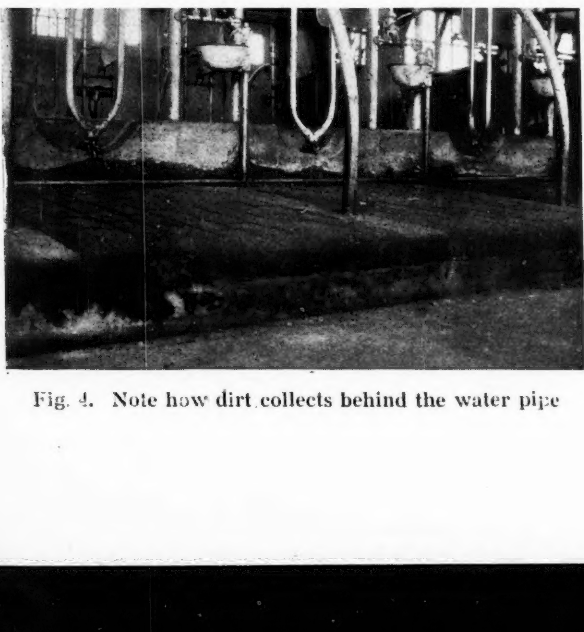

Fig. 4. Note how dirt collects behind the water pipe

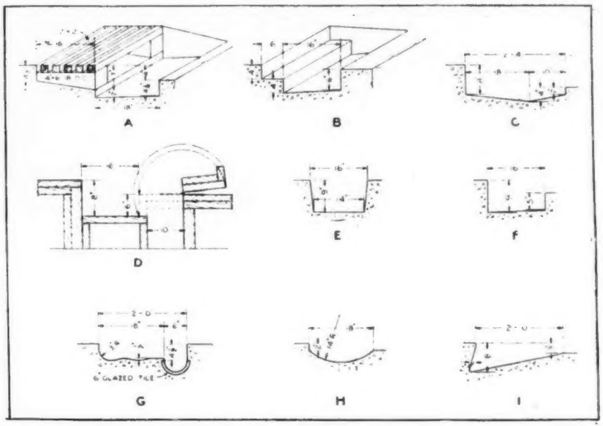

Fig. 5. Several designs of gutters used in dairy barns

frequently. This not only aids in destroying disease germs and bacterial life, but tends to correct the soil acidity where the manure is applied.

The gutters should have sufficient slope to drain well but not so much as to make the gutters deep at one end and shallow at the other. A slope of from $\frac{3}{4}$ inch to 1 inch in 30 feet is sufficient. When the slope is too great the liquid concentrates at one end in quantity too great to be absorbed by the bedding, and, as a consequence, the walls and floor are splattered when the litter is removed. In most parts of the country the liquid manure is absorbed by the bedding and removed in litter carriers. In these sections the drains are used for the purpose of washing out the gutters and for the removal of water after the stall floors have been washed. In the colder sections special provision is made to guard against freezing of the mains. Drains of the trap type with stoppers should be provided, screens being used to prevent the entrance of straw and litter into the pipe lines. Pipe lines should be of cast iron or sewer pipe with cemented joints when they are under the stable floors. In most instances where drains are used for the removal of the liquid manure to cisterns, transfers or cut-off valves should be conveniently located so as to permit the drainage line to the cistern being closed while the floors and walls are being washed. Usually it is not economical to provide storage space for gutter washings, although they do contain some fertilizing elements. One point which is often overlooked until trouble develops is the provision for cleaning of the drain lines. Should they become clogged—and this happens altogether too frequently for those who have not provided means for cleaning—the floors have to be torn up.

If the gutter outlets are placed at the ends of the gutters, near the ends of the barn, less pipe under the floor will be required but this limits the length of gutter that can be drained through one outlet to approximately 50 feet. One outlet may be used to drain almost twice as much gutter, should it be necessary, if it be placed at the center of the run, the gutter sloping both ways. The location of the gutter outlets will be determined largely by the position of the drain outlets. Catch basins should be installed 6 to 8 feet outside of the barn wherever there is an abrupt change in the direction of the drainage lines. The discharge end of the drain lines never should be located close to the barn where they may form puddles of filth for the breeding of flies.

The gutters should be of such shape that they may be easily constructed and without too great cost. The several designs shown in Fig. 5 vary greatly in this respect as will be pointed out later. They should have sufficient capacity to hold the droppings for a period of at least twelve hours

without being filled to such depth that the cows are liable to be soiled. A little forethought in this respect will save much labor in the daily cleaning of the animals. Since the large breeds of dairy cows usually consume a larger amount of roughage than do the smaller breeds, the gutters should be proportioned accordingly. Larger gutters are necessary where straw or shavings are used for bedding than where sawdust is employed. In some sections horse manure is sprinkled into the gutters in order to absorb the liquid. This practice is not permitted under sanitary regulations.

The combination of gutter and stall floors (A, Fig. 5) was designed to obviate the damp condition of the stall caused by liquid standing in small pools. This condition is often found in floors of cork brick which have become badly worn, and concrete floors which are not properly drained. The slatted floor shown was designed to prevent udder trouble due to contact with cold concrete floors and to keep the floor dry. It accomplishes these two purposes very well, but it has the disadvantage of being short-lived and hard to keep clean. Moisture swells the wood and urine enters, and remains in the cracks and crevices producing a foul condition. There are too many cracks that catch and hold dirt. One farmer, because of these objections to the use of wood, had cast iron gratings made; this grate provides good drainage but at an excessive cost. The grates extend across the end of the stall and weigh from 90 to 100 pounds at 8 cents per pound, the cost of the grates per stall would be $8, and in some cases more. The stalls remain dry but the castings, being rough, catch and hold manure, and the slatted openings are almost closed with the accumulation.

The gutter B represents a rather novel construction but is not to be recommended for use in modern barns. The cows, in backing out of the stall, are supposed to step down in two stages instead of one. If the steps are slippery there is danger of a fall, and this happens many times. The gutter trench is too wide and there are too many corners to clean.

Gutter C is likewise too wide and occupies too much of the alley space; the bottom slopes of the gutter may be dangerous. The two slopes make it slightly more difficult to clean with the shovel but permit of better drainage. If the bottom of the gutter is sloped laterally it should incline toward the cow, in order to make the footing more secure, rather than in the opposite direction.

Gutter D represents a type of gutter construction many examples of which may be found in old barns in the New England states. It was designed principally to save labor. Hinged doors are placed about every 6 feet, or behind every other stall. These doors are opened and the manure is dropped to the ground floor or into a pit. Wood floors and gutter construction is usually unsanitary, difficult to keep clean and free from odors, and is apt to be accompanied by other filthy conditions. It is no longer permitted where sanitary regulations prevail.

Gutter E is more difficult to construct than the common box gutter with vertical sides, but the principal objection to this type is that the alley floors are level with the stall floor. This construction makes it difficult for cows to back out of the stall. When the droppings fall on an alley floor which is at the same level as the stall floor, the cows are more liable to become soiled and greater labor is required in keeping them clean. This trouble is minimized when the alley floor is 4 inches or more below the level of the stall floor.

Gutter F is widely used and is the most satisfactory type. There is some difficulty in keeping the vertical sides clean, but this is not a serious objection if the gutter is of the proper proportions. The dimensions will vary somewhat with the kind of bedding used, the size of the cows and the amount of roughage and concentrates fed. The average depth should be from 8 to 9 inches and the width from 16 to 18 inches, though occasionally 20 inches may be desirable for large cows. It will be noted that the alley floor is below the level of the stall floor.

Gutter G shows a foreign type of gutter which is used where little bedding is available and more attention is paid to the saving of liquids which are drained into cisterns. Where these gutters are used the barns are cleaned more frequently. This type is too wide and is more dangerous than some of the other types shown, as well as being more difficult of construction.

Gutter H is a shallow type of gutter. Its principal advantage lies in the fact that as it has a curved bottom the cows are less likely to stand in it. Since this tendency of the cows is usually due to the stalls being too short the length of the stall should be rectified. This type is more difficult than some of the others to clean with a shovel, but if a properly shaped scraper is used this difficulty of cleaning is largely overcome. A bunch of straw may be placed upon the end of a fork and moved along the gutter as an aid in cleaning.

Gutter I is also a shallow type sometimes called the "fade away" gutter. It is suitable for use in barns having a center driveway, since there is no deep depressions into which the wheels of a wagon or spreader may drop. This type may be easily cleaned with a shovel or fork used at right angles to the gutter and not parallel as is necessary in the other types. The use of a scraper of the same shape as the gutter greatly aids in the cleaning of this type. Straight edge scrapers may be used to advantage in the cleaning of alley floors.

Types A, C, F and I are the only gutters which need considered for use in a modern barn. The choice will probably rest between F and I and will depend somewhat upon the arrangement of the barn floor. Where a driveway is desired and only a narrow one is possible, gutter I will be preferable; in other cases either may be used.

Why a Federation of Engineers

AT A JOINT meeting of engineering groups held in the Engineering Societies Building, New York City, May 8, to discuss "The Engineer in Public Affairs," Gano Dunn, president of the J. G. White Engineering Corporation, who presided, urged the need of organized effort by engineers.

"Significant of the trend in the growth of professional engineering life, this meeting has been organized by the Federated American Engineering Societies. The Federation is the out-growth and the embodiment of those things which engineers feel can better be done unitedly than separately.

"The Federation must make its own appeal. The details of its operations and accomplishments must be ultimately that nice balance between strong opposing forces upon which the health of an organization always depends. The history of our own country illustrates that; at the beginning it was almost impossible to form the federation which was called the United States of America. Even our own New York did not sign the Declaration of Independence until three or four months after the Fourth of July.

"I hold these principles to be self evident, that engineers cannot continue to go on as entirely separate and distinct organizations, that there is something in the human side of all the engineering branches that needs contact with other branches, and that there is a yet undeveloped force and power among engineers as a profession that, if properly united and polarized and made to pull all one way, can speak for engineers, can represent them, and can make them a force in the community that they have not yet been made.

It is not a question of whether or not engineers shall federate; it is only a question of the details that that federation shall take.

The Tractor's Place in Hay Making

By Wallace S. Thomas

Mem. A.S.A.E. Vice-President, Thomas Manufacturing Company

THE making of hay does not occupy a very conspicuous place in the annual program of some farmers, nor does it receive a great amount of attention from the agricultural engineering profession in their efforts to reduce the amount of labor necessary for operating a farm. A little consideration will show, however, that in the aggregate hay requires an amount of labor which is of the same order of magnitude as the labor required to produce our largest crops. The acreage of hay in the United States amounts to one-fifth of the total acreage of all the important crops. The total farm acreage of important crops is given by the U. S. Department of Agriculture as approximately 350,000,000 acres. The average acreage of all hay is given as approximately 70,000,000 acres. The acreage in hay exceeds the acreage of any other crop with the exception of corn.

The following production costs per acre are given in Bulletin 179 of the University of Minnesota for the period from 1913 to 1917:

Wheat.........$16.33

Corn.......... 19.00 to 23.00 (depending on method employed).

Timothy hay... 11.22

Alfalfa hay.... 16.59

Not only does hay rank among our most important crops in the matter of acreage, but also in the matter of total value of the crop. The average value of our foremost important crops from 1914 to 1918 is given by the Department of Agriculture as follows: Corn, $2,612,000,000; cotton and cotton seed, $1,354,000,000; hay, $1,309,000,000; wheat, $1,200,000,000.

It is thus evident that the perfection of labor-saving methods in the harvesting of the hay crop will have an important influence on the general economy of operation of American farms.

The most important influence working towards the mor economical operation of the farm is the small gasoline or kerosene tractor. It is the purpose of this paper to discuss, briefly, the influence which the tractor is likely to have upon the harvesting of hay.

Before proceeding with this discussion, it might be well to consider what effect the increasing use of the tractor will have on the demand for hay. It is sometimes stated that the time will come when the tractor will have so completely banished the horse from the farm that there will no longer be any demand for hay.

The hay raised in the United States in 1921 was 96,800,000 tons. The number of horses and mules of workable age on farms in 1921 was 17,100,000. If the average consumption of hay per horse is taken as four tons per year, the hay consumed by all the horses and mules on farms was 68,460,000 tons. This leaves only an amount of hay to be consumed for all other purposes of 28,400,000 tons. This would be assuming a complete displacement of horses and mules from the farm. This latter condition is highly improbable.

Let us consider the amount of displacement that is likely to take place. The total number of farms in the United States in 1921 was 6,448,000; the average number of horses or mules per farm was therefore 2.65. Estimating that there will be one tractor ultimately on each farm of over fifty acres which is operated by a farm owner or by a manager for a farm owner, there will at that time be 1,693,000 tractors in use. This estimate has as its basis the idea that there will not be many farm tenants or renters who will be in a position to purchase or operate a tractor. Multiplying the estimated number of farms on which there will be tractors, by the average number of horses per farm, gives a total of horses displaced by tractors of 4,486,000. This assumes that the average number of horses displaced by tractors is approximately equal to the average number of horses on all farms, the fact that the larger farms have more horses to be displaced, being offset by the fact that not all of the horses are usually done away with by the use of the tractor. The hay consumed by the horses which have been displaced would amount to 17,944,000 tons per year. Subtracting this from the total hay crop leaves still a demand for hay of 78,858,000 tons.

The decrease of 18,000,000 tons in the demand for hay per year would quite likely be made up by an increasing demand for hay for the pasturing of hogs or for dairy cattle. It is therefore probable that the increasing use of the tractor will have little, if any, influence on the demand for hay.

The next point to be considered in this discussion is the question of how satisfactorily the hay crop can be handled with tractors. We will take up separately each kind of work, which is done in harvesting hay.

1. Mowing. Mowing hay can be done successfully in several ways with a tractor:

(a) With horse mowers, drawn singly or in tandem by a tractor, with an operator on each mower and also on the tractor.

(b) With a horse mower hitched to a tractor of the type of the Moline Universal, with the tractor operator sitting on the seat of the mower.

(c) With specially designed tractor mowers, or mowing attachments which are bolted directly to the tractor.

(d) With special motor mowers or power machines, which are designed for mowing and nothing else.

2. Raking. Raking hay can be done successfully with a tractor in the following ways:

(a) With a sulky rake, an operator on the rake as well as on the tractor.

(b) With a side-delivery rake, which does not require an operator on the rake.

(c) With sweep rakes, which are pushed by the tractor.

3. Tedding. Tedding can be done successfully with a tractor, if the tedder is not operated too fast. It is unnecessary to have an operator sitting on the tedder.

4. Loading. Loading hay can be done successfully with a tractor, in the same way it is done with horses.

5. Stacking. The tractor can supply the necessary power for operating a stacker; in fact, patents have recently been taken out on a combined sweep rake and stacker attached to the front of a tractor.

6. Hauling. Hauling hay can of course be done successfully with a tractor.

Certain general objections are often raised against the use of tractors in the hay field. The first of these is that

the angle cleats used on the wheels push the hay into the ground. This is true to some extent in the case of certain varieties of hay which have tough stalks, like timothy hay. A certain amount of timothy hay will be pushed into the ground by tractor cleats, provided the ground is soft. This hay will not be raked out by a side-delivery or sulky rake. However, the amount of hay pushed down is inconsiderable compared with the total amount of the crop. Tractor cleats running over varieties of hay which have soft or pithy stalks, like alfalfa, will cut the stalks completely in two. This again seems to have practically no influence on the total crop.

Another objection which is raised against the tractor for hay making is that it injures the hay by running over the swath, in that it threshes off the leaves. This seems to be negligible. The hay is usually raked before it gets dry enough to shatter, so that the tractor does not injure it any more than do horses.

Having outlined how the hay crop can be handled by a tractor, the next point to be discussed is the economy of these various operations.

1. Mowing

(a) Cutting hay with one or more horse-drawn mowers drawn by a tractor, where two or more men are required, is probably not economical on account of the increased labor cost involved.

(b) Cutting hay with a horse-drawn mower attached to a tractor of the type of the Moline Universal, which requires only one man, is probably as economical as horse mowing The greater cost of operating the tractor, as compared with the cost of a team of horses, would be counterbalanced by the greater amount of hay which could be cut in a given time.

(c) Specially designed tractor mowers and mowing attachments for tractors have made it possible to cut hay at the rate of three acres per hour. The average cost of tractor operations per hour, including the driver, is given by the Pennsylvania State College, Bulletin No. 158, (May, 1919) as $1.23 per hour. This makes the cost of cutting hay per hour, excluding machine cost of the mower, 41 cents per acre when three acres are cut per hour. The average cost of horse mowing, including the horse and operator cost, is given by the University of Minnesota, Bulletin 179 for the period from 1913 to 1917, as 60 cents per acre. Thiss also excludes the machine cost. The machine costs of the special mower and the horse mower are estimated to be approximately equal on account of the greater durability of the special machine, and the greater acreage which can be cut during its life, as compared with the life of the horse mower. Based on these figures there is a 30 to 40 per cent saving in the cost of mowing hay with a tractor, over mowing hay with horses. The actual saving would probably be greater if figures for both were available which were obtained at the same time. The intangible advantages are also on the side of tractor mowing, such as greater insurance against crop spoilage due to more rapid harvesting.

(d) No figures are available for the cost of mowing with a special motor mower, these machines being still in the experimental stage.

2. Raking

(a) It is probably poor economy to rake hay with a sulky rake and a tractor, on account of the necessity of having an operator ride on the rake, as well as on the tractor. The dumping mechanisms of the present types of sulky rakes require an operator who sits on the rake. The operator of the tractor can of course sit on the rake, provided the tractor is equipped with extension control.

(b) Raking hay with a tractor and a side-delivery rake is questionable economy. Very little more ground can be covered with a tractor than with horses, unless two rakes are pulled by one tractor. This makes a complicated hitch, and a larger investment in machinery.

(c) Raking hay with a sweep rake attached to the front of the tractor would very probably show an economy over a sweep rake pushed by horses. The tractor sweep rake could carry greater loads than the horses, and could make better time transporting the load to the stack, especially in the case of tractors which have a geared-up speed for road transport.

3. Tedding. Tedding hay with a tractor is doubtful economy. Very little more ground can be covered than with horses.

4. Loading. Loading hay with a tractor is questionable economy. A tractor cannot travel faster with a loader than do horses, and the use of a tractor often necessitates an extra operator. More time is lost in hitching the tractor and the loader to the empty wagon. However, more uniform loading is possible with a tractor, on account of the steady and closely regulated speed which can be maintained by it.

Patents have recently been taken out on a tractor loader and wagon hitch, which may result in greater economy in this operation. The loader and wagon are hitched to each end of a long chain. This chain passes from the loader forward to a pulley on the tractor drawbar at the left-hand side of the tractor, and then across the tractor drawbar to a pulley at the right-hand side of the drawbar, and from there back to the wagon. The loader is equipped with a chute, which will deliver the hay from the loader to the right-hand side. The loader and the wagon are thus drawn side by side. By means of a hand wheel on the tractor, the wagon and loader can be shifted in their latitudinal relation. The load on the wagon can be started at the rear of the wagon, and then the loader is gradually drawn up towards the front of the wagon until the load is completed. The wagon is then unhitched and an empty wagon substituted in its place.

5. Stacking. Nothing is known about the economy of stacking hay with a tractor.

6. Hauling. The economy of hauling hay with a tractor depends upon the method of making hay, and on the general layout of the farm. If the hay is to be hauled from the field directly to the barn, it can probably be done more economically with horses, unless several wagons can be hitched behind each other for the tractor to pull.

It is therefore probable that hay can be satisfactorily and economically cut and raked up with a tractor. How can the power and speed of the tractor be applied to the other operations necessary on the hay crop? A successful tractor sweep rake and stacker combined would probably answer this question on Western farms. The problem in the East and South is one of haulage and storage. If the hay crop is to be stored loose in the barn, it must be loaded on a wagon, hauled to the barn, and unloaded in the barn, all of which are expensive operations. If the bulk of the hay could be reduced, it would make possible greater economies in these operations. A patent which has recently been taken out in California, bears on this point. It is on a combined hay loader and hay press. It amounts to a hay press, which is drawn along the windrow, with an attachment which picks the hay up out of the windrow and delivers it to the press. The hay is then delivered in a baled condition direct from the windrow. It could then be much more cheaply hauled, handled and stored, and its value would be augmented by the fact that it is baled. It would necessitate a dry hay making season for its successful use, in order that the hay might completely cure in the windrow.

The only special tractor hay machinery which has been developed to a sufficient state of perfection to warrant its being marketed commercially, is the tractor mower and

mower attachment. It might be of some interest to discuss the problems involved in the perfection of these machines.

The tractor mower is a drawbar machine, hitched only to the drawbar of the tractor, and in its fundamentals is practically the same as a regular horse-drawn mower. The mower attachment is a device which uses cutting parts designed along the same lines as a horse-drawn mower, but these cutting parts are operated directly by the power of the tractor engine. It thus eliminates a great many of the parts of the horse-drawn mower.

The first question to be decided in the designing of these machines was the proper size for tractor use. It has been found possible to use as high as 10-foot cutter bars on tractor mowers. The draft of the 10-foot cutter bar is not great enough to tax even the two-plow tractor to its capacity. An average drawbar pull of 566 pounds has been obtained from pulling a 10-foot mower 2½ miles per hour. The 10-foot bar would seem to be the practicable limit of size for a mower cutter bar, and even it is too large for a great many purposes. It has to be considerably stiffened to prevent excessive sagging when the bar is raised off of the ground. It is so heavy that it takes great effort to raise it to a vertical position for transport. When raised vertically it extends so high in the air that it cannot be housed in the average barn or implement shed. The knives are so long that they are extremely awkward to grind. This is counterbalanced by the fact that the knives require considerably less sharpening than shorter knives. Each section cuts less grass for a given acreage cut by the mower. The 8-foot length cutter bar has been found more satisfactory for general use, and when drawn at a higher rate of speed, say 3 to 4 miles per hour, would require approximately the same drawbar pull.

The greatest width of cutter bar which has been found practical for mower attachments is 6 feet. There are apparently two main reasons for this: The first is that a greater width of cut would put excessive sidedraft on the tractor; and the second is that a longer cutter bar would be extremely difficult to raise by a hand mechanism, such as is necessary with a mower attachment. Increased cutting capacity is secured by increasing the speed of cutting. Mower attachments have actually been used to cut hay at as great a speed as 12 or 15 miles per hour, and the standard cutting speed for some of them is 5 or 6 miles an hour.

The longer cutter bar on tractor mowers, and the high speed of operation of the mower attachment, made necessary a great many changes in the design of parts. The longer cutter bar requires more strongly constructed machines, heavier knives and pitmans. The higher operating speed of both of these types of machines as compared with horse mowers necessitated improved bearings and lubrication. On the shafts which attain the highest rotative speed, namely, the crank or flywheel shaft, and the pitman shaft or wrist pin, it has been found desirable to use anti-friction bearings, either roller or ball. These bearings make it possible to operate continuously at a high rate of speed, which would not be possible with the type of bearings ordinarily used on horse mowing machines. The bearing loads on horse-drawn mowers are not only lighter, but it is customary in cutting hay with horses in the hot harvest season to stop frequently to let them rest. These rest periods not only cool off the horses but also cool off the bearings, and give the operator an opportunity to oil the bearings. When a mower is being operated continuously by a tractor, it is therefore necessary not only to have better bearings, but also to provide better means of lubrication. It has been found desirable to operate the mower gears in a bath of oil; with most types this oil also circulates to the bearings which are subjected to the greatest load. Frequent stops for oiling are therefore unnecessary, and the machines can be operated practically all day with very little lubrication.

In order to make it unnecessary for an operator to ride on the seat of the tractor mower, it was necessary to develop a power-lifting mechanism for the cutter bar. The mower can therefore be handled as easily from the seat of the tractor as can a plow or harrow. With a quick-acting lifting and dropping mechanism the cutter bar can be handled as accurately as it can be by the foot of an operator sitting on the mower.

All mower attachments have been so designed that they can be conveniently operated by the tractor operator. They use a hand-lifting mechanism for the cutter bar, it having been found impractical to design a foot lift on account of the fact that the tractor operator ordinarily uses one of his feet for the tractor clutch pedal.

One of the greatest difficulties in using a mower in connection with a tractor is the question of protection against possible accident, such as running the cutting apparatus of the mower into stumps or stones. Protection must be of two kinds: First, the cutter bar and its connecting mechanism must be protected against damage due to striking solid obstacles. This is done in the case of the tractor mower by connecting the mower to the tractor by means of a wooden shear pin. It is done in the case of most of the mower attachments by a mechanism whereby the tractor itself is stopped whenever the cutter bar comes in contact with an obstacle which causes the bar to be bent slightly to the rear. The second type of protection is against damage to the cutting parts due to catching some object like wire between the guards and the knife sections. In the case of a tractor mower, protection arises out of the fact that the cutting mechanism is being driven by power derived from the ground. If for any reason the cutting mechanism becomes choked, the mower wheels will slide, thus preventing damage. In the case of the mower attachments, where the cutting mechanism is driven by the power of the tractor, this protection is obtained by introducing a safety clutch which will only transmit a predetermined amount of power, or is obtained by considerably increasing the strength of the cutting parts, so that they are practically strong enough to cause the tractor engine to choke, if for any reason the mower knife itself is choked, or by so designing the cutting parts that the knife section is the weakest link in the driving chain, and will be torn off of the knife back if it encounters an obstacle.

To sum up this subject in a few words, hay making can be done successfully and economically with tractors, especially if certain new types of machines are developed commercially. The increasing use of tractors will probably have little influence on the total consumption of hay, but rather may change slightly the avenues of its consumption.

Grain Storage

THERE seems to be no reason why a grain storage should not be built round, and there are a great many why they should. In any type of masonry construction it is more desirable to build such buildings round than rectangular. The material required is less in both the steel and of other materials, and the construction is much more dependable from the standpoint of strength and ability to withstand expansion and uneven settling strains.

It has been found that sweating is very much less in granaries where there is an air space in the wall and which results in a dryer grain bin. This also is true of the floor. In order that no moisture can be carried through the mortar or concrete, it has been found advisable to apply one or two coats of waterproofing paint to the inside surface, to any kind of a masonry wall, which the grain is to come in direct contact with.

Agricultural Engineering Digest

Abstract of Current Literature on Engineering as Applied to Agriculture

Edited by **R. W. Trullinger**

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A STUDY OF EXPLOSIONS OF GASEOUS MIXTURES, A. P. Kratz and C. Z. Rosecrans. [Illinois University Engineering Experiment Station Bulletin 133 (1922), pp. 101, figs. 38.] This is a preliminary report of the methods pursued and the results thus far obtained from studies in progress on the effect of varying proportions of gas and air, initial pressure, shape of explosion vessel, ratio of its volume to its area, position of ignition, and turbulence during the time of ignition on the rate of inflammation, maximum pressure, and time of explosion of various combinations of commercial gaseous fuels in internal-combustion engines.

The studies also included tests with the temperature of ignition corresponding to the temperature found at the end of compression in different types of commercial internal-combustion engines, the purpose being to draw conclusions relative to the effect of variations in the carbon hydrogen ratio upon factors leading to pre-ignition in internal-combustion engines. The results with various mixtures of illuminating gas and air showed that a ratio of air to gas of about 4:1 gives the maximum explosion pressure and minimum time for explosion.

In general the effect of turbulence during explosion was to cause an increase of maximum pressure and a decrease in the time of explosion. This effect was greater for lean mixtures than for the richer ones. The maximum pressure was also produced with a slightly greater air-gas ratio than for the case where no turbulence existed. The effect of turbulence seemed to be due to the more intimate mixing of the gas and air before inflammation, thus bringing more molecules into contact, rather than to the projection of the flame into the unburned parts of the gas mixture.

The position of the source of ignition had a considerable influence on the rate of inflammation and on the maximum pressure. In vessels patterned after the L-head type of combustion space used in internal-combustion engines, ignition in the valve chamber resulted in a maximum pressure of about ten per cent less than that obtained when ignition occurred at the center of the head. Both turbulence and variations in the position of ignition seemed to have more influence on the rate of inflammation than on the maximum pressure.

In certain cases there was some evidence of the formation of pressure waves which travel smoothly through the mixture and produce a higher maximum pressure than if the inflammation had proceeded in the usual way. These pressure waves differed in character from true explosion waves.

The maximum pressure and time of explosion were affected materially by the shape of the explosion vessel. This seemed to be caused by variations in the ratio of surface to volume for the different vessels. From the standpoint of maximum pressure produced, the spherical explosion vessel was best. The cylindrical and conical vessels gave about the same results, but the maximum pressure was about 8 per cent lower than that for the spherical vessel. The L-head type gave results about 16.5 per cent lower than the spherical.

The combustion of the gases in any pocket in the vessel was more or less incomplete due to the cooling effect of the walls. The incomplete combustion resulted in a reduction of the maximum pressure.

The cooling of the gases for a given mixture during any time after the attainment of maximum pressure varied directly with the ratio of surface to volume of the explosion vessel, for the particular vessel used.

Radiation from the gaseous mass was an important factor in the cooling of the mixture. Variations in the character of the inner surface of the walls of the vessel caused variations in the cooling curves.

The experimental results for the maximum pressures produced by explosions of hydrogen and air agreed very closely with the values computed from the properties of the gas mixture.

INCREASED APPLICATION FOR THE VENTURI FLUME, H. K. Smith. [Reclamation Record (U. S.) 13 (1922), No. 11, pp. 284, 285, figs. 2.] Attention is drawn to the fact that operating conditions on an irrigation project often require that a small quantity of water be delivered through a ditch of considerably greater capacity, and at the same time it is required that the water be backed up until the ditch is practically bank full.

It is stated that the capacity of the Venturi flume, as developed at the Colorado experiment station and Cornell University, is limited in that the accuracy of measurement of a small discharge at a high-gauge height is doubtful. The problem is to so construct or modify the Venturi flume that an error of 1/100 foot in gauge reading will not be material when delivering water to the farmers.

It has been found possible to overcome this difficulty by installing a plug in the throat of the flume, thereby reducing the water area. This plug consists of two weir boards bolted together, the sharp edges of both boards being toward the throat. By means of this plug a flow that in the standard design will cause a draw of from 1/100 to 2/100 foot will cause a draw of from 10/100 to 12/100 foot, thus making the customary error of much less moment.

It is stated that four sizes of the Venturi flume are in use, having throat widths of 12, 18, 24, and 30 inches. For the 12 and 18-inch sizes the height of the plug used is nine inches and for the two larger sizes the height is fifteen inches. These plugs have proven quite satisfactory and are said to have increased greatly the accuracy of water measurements.

ON A NEW METHOD OF GAUGING THE DISCHARGE OF RIVERS, J. Joly. [Royal Dublin Society of Science Proceedings, n. ser., 16 (1922) Nos. 35-39, pp. 489-491.] This is a brief description of the application of the principle of chemical hydrometry to the measurement of the discharge of rivers. It is stated that very accurate results have been obtained by this method, the error being reduced to below one per cent. The method is considered to be superior in accuracy to weir measurements and very much superior in accuracy to measurements based on current meters.

RECENT FARM BUILDING LAYOUTS (in Rhine Province), D. Speckmann [Technical Landwirtschaften, 3 (1922), No. 4, pp. 84, 85, figs. 3.] Plans showing recently developed schemes in the arrangement and location of farm buildings on average sized farms in the Rhine Province, Germany, are presented and discussed.

HANDBOOK OF CONSTRUCTION COST, H. P. Gillett [New York and London: McGraw-Hill Book Company, Inc., 1922, pp. XVII-1734, figs. 296.] This handbook contains 1,734 pages of data on engineering economics and the costs of engineering construction of all kinds. Special sections are included on costs of construction of concrete structures, dams, reservoirs, waterworks, irrigation and land drainage structures, highway bridges and culverts, and roads and pavements.

PORTLAND CEMENT CONCRETE ROADS, J. T. Voshell and R. E. Toms [U. S. Department Agriculture Bulletin 1077 (1922), pp. 67, pls. 10, figs. 15.] This bulletin presents technical information on the design and construction of concrete pavements for the use of highway engineers and others. Information is also included on organization and equipment, capital required, cost of concrete pavements, maintenance, and resurfacing.

PLAIN CONCRETE FOR FARM USE, T. A. H. Miller [U. S. Department Agricultural Farmers' Bulletin 1279 (1922), pp. 27, figs. 19.] This bulletin discusses the requirements of good concrete, and describes the making and placing of plain concrete according to the best practice.

ECONOMIC GRADES SAVE MOST GASOLINE, C. Lewellen. [Iowa Engineer, Ames, 23 (1923), No. 4, pp. 7-9, figs. 3]. A description of the testing apparatus used in studies of the relation between highway grades and the consumption of fuel by motor vehicles, conducted by the engineering experiment station of the Iowa State College is given in this report. These experiments have indicated that the average gasoline consumption in gallons per 1,000 ton-miles is smaller for a round trip with the motor declutched on down grades than it is for a round trip with the clutch engaged over the entire course.

ECONOMIC THEORY OF HIGHWAY GRADES, T. R. Agg. [Engineering News-Record, New York, 90 (1923), No. 2, pp. 76-79, figs. 7]. This is a more detailed report of studies, some of the results of which are presented in the above. It has been found that momentum grades on rural highways are economical, both from the standpoint of fuel and time, and that under certain circumstances less fuel will be required on a road with an undulating grade line than on one with very flat grades.

TRACTOR SITUATION IN ALABAMA, M. L. Nichols and J. W. Randolph. [Alabama Station Circular 46 (1922), pp. 7, fig. 1.] A summary of a tractor survey in the State of Alabama, consisting of 125 replies to questionnaires sent to tractor owners, is presented in this report.

Tabular data are given indicating that size of farm is not necessarily the most important factor in determining tractor profits or losses. All farms under 50 acres reported that tractors used thereon were profitable. Reports from farms of from 100 to 150 acres indicated that these sizes are just as profitable as farms of from 500 to 1000 acres for tractor farming. The two-plow tractor was the most popular size. The results of an analysis of the sizes of tractors used are taken to indicate that Alabama tractors are not generally overloaded.

The number of acres plowed by each tractor during 1920 varied from 10 to 600 acres. The data indicates that with increased power many farmers in Alabama are working more of their land instead of substituting power for mules. It is noted that questions dealing with lubrication, cooling, etc., were answered so vaguely as to make the results impossible of tabulation. It is concluded that Alabama stands in about the same position as the northern and middle western states as regards percentage of profitable and unprofitable tractors.

LONGER DURABILITY FOR FENCE POSTS AND FARM TIMBERS, I. T. Bode. [Iowa Agricultural College Extension Bulletin 109 (1922), pp. 16, figs. 12, published at Ames.] Practical information on the creosoting of fence posts and other farm timbers, with particular reference to conditions in the State of Iowa, is presented in this bulletin. The information is based on experiments at the Iowa experiment station in which it has been found possible to increase the life of ordinary woods, such as cottonwood, willow, and soft maple, to twenty years or more. Creosote has been applied either by the brush or hot spray method, or by the open-tank-immersion method.

It has been found that for fence posts the brush treatment, while slightly beneficial, is not thorough enough to insure very complete protection against decay, and the conclusion is drawn that the life of soft woods is increased hardly enough by this treatment to pay for the trouble.

THE FUEL VALUE OF WOOD, I. T. Bode. [Iowa Agricultural College Extension Bulletin 111 (1922), pp. 4, Ames.] Data on the relative

fuel value of different Iowa woods under different conditions of seasoning are briefly presented.

It is stated that important factors which influence the heating value of wood are species, part of the tree from which the wood comes, seasoning, and method of burning. It has been found that the most efficient wood fuel is that which has been the most thoroughly seasoned. The heartwood of the tree is said to be better for fuel than the sapwood. Generally the softwoods burn more quickly than the hardwoods, and the lighter hardwoods burn more quickly than the heavier hardwoods. Pines give a quicker, hotter fire than birch but are consumed more quickly. Birch gives a more intense flame than oak, but the oak gives a steadier heat.

Humidity Requirements for Residences, A. P. Kratz. [Journal of the American Society of Heating and Ventilating Engineers, New York, 29 (1923), No. 1, pp. 14-18, figs. 5.] In a contribution from the University of Illinois, data are presented on humidity requirements for artificially heated residences. These indicate that a room at 69 degrees Fahrenheit will be comfortable if the relative humidity is maintained at a value of from 35 to 45 per cent. A relative humidity of about 40 per cent is considered to be as high as it is practical to maintain in residences. If the humidity is much higher than this the condensation on the windows will be excessive unless double windows are used.

Data on the amount of water in gallons per hour required to humidify 10,000 cubic feet of space are also presented.

Some Ways of Increasing the Duty of Irrigation Water, W. L. Powers. [Soil Science, Baltimore, 14 (1922 [illegible] figs. 2.] In a further contribution to the subject from the Oregon experiment station, some additional data bearing on a few of the chief ways of increasing the duty of irrigation water are presented. Graphic data from field tests are given showing the usable water capacity of different classes of soils. It was found in experiments that a three-year rotation receiving manure under irrigation increased the net profit more than a similar rotation without manure during a nine-year period. The yield and net profit per acre-inch of irrigation water were almost doubled by the rotation and manure, and the water requirement per pound of dry matter was reduced nearly one-half by these treatments.

Tank experiments to determine the water requirement of oats grown on two soils with different fertilizer treatments showed that a fertile soil had moderate variations in water requirements with the different treatments, while a soil of medium fertility had a striking difference in yield and water requirement. This is taken to indicate that the richer and better balanced nutrient solution results in a lower water requirement.

It is stated that "the irrigation requirement and water requirement will vary somewhat with the season and anything which affects the evaporation, percolation, or transpiration of soil moisture. Anything that contributes to good irrigation farming, such as planting, irrigating, or cultivating at the right time, tends toward economical use of irrigation water."

Report on Investigations Into the Improvement of River Discharge Measurements, II, E. B. H. Wade. [Egypt Ministry of Public Works, Physical Department Paper Cairo 6 (1922), pp. 12, pls. 14.] In a second report on the subject, it is shown that when the velocity of a stream is very low its measurement presents special difficulties. There is, therefore, a demand for an improved type of current meter to deal with the case of sluggish flow. A type of current meter for this purpose is described, in which a helix is driven by an independent constant power, and the effect of the stream is merely to increase or decrease the rate of the helix by an amount which serves as a measure of the velocity of the stream. Data are presented showing the advantage of using an independent constant power in this manner.

Vaporization of Motor Fuels, P. S. Tice. [Journal of the Society of Automotive Engineers, New York, 11 (1922), No. 4, pp. 307-319, 322, figs. 7.] The purpose of this paper is to summarize the conditions surrounding and controlling fuel vaporization in the cycle of operation of a throttle-controlled internal-combustion engine, fitted with an intake manifold and a carburetor. In this connection a brief and purely qualitative treatment of the characteristics of a vapor is given, and the necessity for vaporizing a liquid fuel before attempting to burn it, the separate effects of the conditions that control vaporization, and heat balance of vaporization are discussed. The conclusion reached from the discussion and from actual demonstrations is that it is well to depend as little as possible on the cylinder heat and temperature to complete the vaporization of the fuel.

The Comparative Merits of Benzol and Gasoline as Engine Fuels, W. O. Hinckley. [Journal of the Society of Automotive Engineers, New York, 11 (1922), No. 4, pp. 359-362, fig. 1.] The process of manufacturing benzol is described and specifications for motor benzol are presented. Comparative data in regard to end point, heat value, and vapor tension for motor benzol and gasoline are presented, together with a description of comparative engine tests. The results for a fleet of vehicles were about ten per cent in favor of motor benzol over gasoline.

Notes on Motor Trucks, C. T. Myers. [Journal of Society of Automotive Engineers, New York, 11 (1922), No. 4, 333-345, figs. 12.] An outline is given of some of the reasons why certain weight reductions in motor trucks are misleading and difficult to effect. The use of aluminum to effect weight reduction is commented on, and the various advantages claimed for metal wheels are discussed. It is pointed out that while these claims may be true, they are unsupported by reliable data. A series of tests of over a year's duration to determine the relative merits of wood and metal wheels are described. Four trucks, each equipped with wood and metal wheels on diagonal corners to secure an equalization of conditions, were employed.

It was found that the average wear of the tires mounted on metal wheels was about thirteen per cent greater than that of those mounted on wood wheels. The question of unsprung weight is discussed, as is also the importance of reducing chassis and body weights to a minimum. It is pointed out, however that a reduction in these weights does not necessarily mean a resulting saving in the gasoline consumption or the tire expense. Lubrication is also discussed, and the superiority of oil over grease as a chassis lubricant is emphasized.

Vegetable Oils as Colonial Carburants, H. Jumelle. [Agronomie Coloniale, Paris, 7 (1922), No. 59, pp. 345-354.] A summary is given of experience in the use of vegetable oils as fuels for internal-combustion engines in the French African colonies. These oils include, among others, palm, copra, peanut, and sesame. The two latter oils are said to have the highest calorific values and all compare quite favorably in this respect with gasoline and benzol. They have considerably higher calorific values than alcohol, crude tars, and producer gas.

Tests of palm oil in tractor and stationary engines are described. Laboratory and plowing tests with a Swedish tractor equipped with a 16-horsepower semi-Diesel motor showed that about the same results were accomplished with palm oil as with kerosene, but that the unit consumption of the palm oil was apparently somewhat greater.

On the Characteristics of Cylindrical Journal Lubrication at High Values of the Eccentricity, T. E. Stanton. [Royal Society (London) Proceedings, Series A, 102 1922), No. A 716, pp. 241-255, figs. 6.] Studies of cylindrical journal lubrication are reported, in which it was found that by increasing the difference between the radius of the bearing and that of the journal to an extent very much in excess of ordinary practice, it was possible to obtain steady conditions of lubrication with an arc of contact of the oil film as small as 15 degrees, the fluid pressure in the film amounting to as much as 3.5 tons per square inch.

From the observed pressure distribution in the film, it was found possible to predict the angular position of the point of nearest approach of the journal and bearing, and hence by a comparatively simple calculation, to obtain from the theoretical expression for the pressure slope the values of the eccentricity of the bearing and the mean viscosity of the lubricant. In the case of a journal one inch in diameter it was found that the ordinary equations of motion of a viscous fluid held for flow between the inclined surfaces at a distance apart of 0.00005 inches.

In all the cases of cylindrical bearings under steady lubrication conditions which were examined, the actual measured distribution of pressure was found to agree fairly closely with the theoretical distribution obtained from the integration of the equations of motion of a film of lubricant separating two surfaces of the same dimensions, attitude, and eccentricity as the existing bearing and journal, the film having the same viscosity as that of the lubricant actually used.

Motors of Machines for Mechanical Cultivation, G. Passelegue. [Annales de L' Institut National Agronomique, Paris, 2. series, 16 (1922), pp. 167-196, figs. 9.] A description is given of methods of studying tractor motors at the Station d' essais de Machines of l' Institut National Agronomique of Paris, and the results of typical studies on motors of varying sizes, speeds, and numbers of cylinders are presented and discussed to show how different basic relations are arrived at. Special attention is paid to studies of the influence of different types and grades of fuels, and their influence on the accomplishment of different motors is graphically presented.

Stump Land Reclamation in Oregon, H. D. Scudder. [Oregon Station Bulletin 195 (1922), pp. 5-62, figs. 40.] This bulletin describes a new method of land clearing by burning stumps, and reports the results of experiments made by the station. The new method is adapted to the clearing of big stump land. The burner parts used include a furnace, hood, draft pipes, and chimney. By means of these parts a hole is burned through the base of the stump, and then the stump itself is converted into a stove, which with its own draft, chimney, and fuel develops a fire in its interior so intense as to insure its combustion and the firing of the roots. When this is done the stump is banked in with earth and the crown and roots are burned out below plow depth as a char pit.

It has been found that with certain minor exceptions any species of stump of reasonably sound combustible wood, of sufficient size to justify the use of fire, and with roots sufficiently large to carry a fire well, is a desirable subject for the use of the burner. The paramount value found in this method is that the bigger the stump the better it burns. The cost of burning has been found to decrease as the diameter of the stump increases. Stumps three, six, nine or twelve feet in diameter are those which the burner consumes most economically and completely. The experiments indicated that the removal of the smaller stumps up to about eighteen inches in diameter is best accomplished with a puller supplemented with explosives and that the cost of pulling the smaller stumps is economically feasible.

The experiments showed further that green stumps of any kind do not burn satisfactorily, and that the use of the burner methods should not be attempted. All types of soil were used in the trials and only the sandy type was found to be unsatisfactory. Fine sandy loams containing sufficient clay and silt to hold together when shoveled wet were found to do sufficiently well, but any type sandier than these usually made an unsatisfactory bank. The most satisfactory banking was done when the soil was moist. Detailed information is given on the procedure followed in the use of the burner method.

A second part of the bulletin describes preliminary steps in land clearing and other methods of burning and removing stumps. It is stated that the use of chemicals for the destruction of stumps has been found to be an unsuccessful method.

The Farm Tractor in Mason and Berkeley Counties, A. J. Dadisman, J. H. Shaffer, and F. D. Cornell. [West Virginia Station Bulletin 180 (1922), pp. 3-12, figs. 4.] Data showing records of tractor operations and cost, obtained by personal visits to sixty farms in two sections of West Virginia on which tractors had been in operation for at least one year, are summarized in this bulletin. Tractors ranging from 8-16 to 12-25 horsepower and designed to pull two fourteen-inch plows were used almost entirely.

The cost of operating a tractor was $7.91 per day, exclusive of operating labor. The tractor plowed 5.84 acres per day with a two-plow outfit at a cost of approximately 1.35 per acre, exclusive of labor. It required approximately 2.1 gallons of gasoline or 2.7 gallons of kerosene to plow an acre. Tractor power was a substitute for only a part of the horse power on the farm. The greatest factor in successful tractor work was an efficient operator. Tractors were operated by farmers, their sons, and hired men, and not by professional operators of tractors. No injurious packing of soil was caused by the wheels of the tractor when the soil was in proper condition to be worked. Tractors which had service stations easily accessible gave the greatest satisfaction. Tractors were used an average of 41.66 days per year.

Alkali Investigations (at the California Station). California Station Report 1922, pp. 50, 51, 52, 53.) In experiments in vineyard soils by W. P. Kelley, it was found that simple leaching without

gypsum proved in certain cases to be almost as effective as when gypsum was used, while in other cases leaching alone has been less effective.

Field experiments on the effect of the use of elemental sulphur showed that sulphur produced very little chemical effect on alkali. Laboratory studies by E. E. Thomas showed that sulphuric acid, gypsum, elemental sulphur, ferrous sulphate, and alum are effective means of neutralizing black alkali.

Studies by A. B. Cummins on the formation of sodium carbonate in soils have shown that almost any soil can be made alkaline by first treating it with a neutral sodium salt and then leaching. It was also found that several different pure minerals when treated with a neutral sodium salt and then leached give alkaline solutions.

Studies by A. R. Davis and West on the effect of common salt on wheat, barley, rye, and dwarf peas grown in the greenhouse in solution cultures showed that the tolerance limits for sodium chlorid were about the same for all the plants. In general, plants in concentrations of 9000 parts per million reached maturity before death occurred. Above this limit growth was inversely proportional to salt concentration until the limit of 15,000 parts per million was reached. Above that point no growth took place. The peas were slightly more susceptible to the higher concentrations than the cereals. In all plants certain concentrations of salt differing with the plant used stimulated vegetative growth. A direct relation was evident between the salt added and the time of maturity, the general effect of the sodium chlorid being to hasten this process.

Studies of the areas of soils affected by alkali in the State, compiled by C. F. Shaw, have shown that of the 13, 191, 682 acres surveyed in the Sacramento and San Joaquin Valleys about 14.6 per cent are affected by alkali accumulations.

Studies by W. W. Mackie on the influence of rice production on the alkali content of soil showed that the loss of alkali from the soil under rice irrigation averaged 28 per cent. A selective action retained the sodium sulphate and chlorid ions but permitted the bicarbonate, calcium, and magnesium ions to pass. A small increase in alkalinity was apparent in the soil with the appearance of carbonate and bicarbonate ions. A more disturbing feature was the loss of calcium and magnesium and the increase of the sodium. Deposits of silt from rice irrigation varied from 3 inches near the intake of the plats to 0.5 inches or less at the most distant points.

Agricultural Engineering (at the California Station). California Station Report 1922, p. 21.) Disk harrow tests by A. H. Hoffman and E. J. Stirniman, consisting of 533 fifty-foot runs in three fields, showed that at speeds ranging from 0.5 to 6.1 miles per hour there was no increase in draft with an increase in speed, and that in some cases there was a slight but definite decrease. With a set of angle of gangs of 18 degrees, cutaway disks pulled 15.5 per cent harder than full disks. Cutaway blades broke much more readily than full blades. The draft apparently increased as the angle at which the gangs were set increased from 3 to 23 degrees.

Irrigation Experiments at the California Station. (California Station Report 1922, pp. 104-107, figs. 4.) Studies by F. J. Veihmeyer and S. H. Beckett on the losses of moisture from cultivated and uncultivated uncropped irrigated soils, including sandy soil, dense clay, silt, sandy loam, and clay loam soil containing gravel, showed that the differences in the losses of moisture between cultivated and uncultivated soils are so small that they fall well within the limit of probable error. No loss of moisture by lateral movement was detected. No significant difference in the distribution of moisture was noted to a depth of twenty inches in the cultivated and uncultivated soils.

Similar experiments with clay loam soil in potometers showed that the loss of moisture by evaporation directly from the surface for three months during the summer was very small and was not affected by cultivation. Tanks containing soils, the surfaces of which were uncultivated, lost no more than tanks containing soils the surfaces of which were cultivated to depths of 6, 8, and 10 inches. Additional observations, both with potometers and in the field, showed that the loss of moisture from cultivated and uncultivated soils was confined almost entirely to the surface foot.

Field and potometer observations on transpiration losses by Veihmeyer and A. H. Hendrickson indicated that the moisture lost directly by evaporation from the surface of the soil is negligible as compared to the water required for the support of a crop. Observations by Viehmeyer to determine the seasonal water requirements of young prune trees showed that during the winter months, from the time the leaves drop in the fall to the beginning of activity in the spring, there was a very slight loss of moisture by transpiration. Further observations by Hendrickson and Veihmeyer indicated that moisture losses by transpiration slowed down in the early afternoon of each day.

Moisture equivalent studies by Veihmeyer working with a thoroughly mixed and screened clay loam soil indicated that the amount of soil used in a moisture-equivalent determination has a marked effect on the result obtained, the higher moisture equivalents being usually obtained with smaller samples. Further studies on the technique of soil moisture determination are briefly described.

Killing Trees and Stumps with Chemicals. (California Station Report 1922, p. 96.) Experiments conducted by W. Metcalf on the killing of trees by using the Australian arsenical formula, consisting of a mixture of one pound of white arsenious oxid, one pound of washing soda, and four gallons of water are briefly described. The trees were girdled at or near the ground by downward cuts of the axe and the solution poured into the cuts using a pint or less per tree. Ten species of eucalyptus, including all of those commonly planted in California, were treated with perfect success. The treatment apparently can be applied successfully at any time of year, but winter or early spring is recommended. Trees were also successfully killed by the application of the solution in holes bored about four inches apart around the stump.

Paint, Varnish, Turpentine, and Linseed Oil Laws in Existence August 1, 1922. (Philadelphia: G. B. Heckel, 1922, pp. 94.) This pamphlet, issued under the authority of the central committee of the National Paint, Oil, and Varnish Association, the Paint Manufacturers Association of the United States, the National Varnish Manufacturers Association, and the Dry Color Manufacturers Association, by G. B. Heckel, Secretary, contains the texts of the laws of the different states regulating the manufacture and sale of paints, varnishes, oils, and constituent materials.

California, Colorado, Georgia, Iowa, Massachusetts, Minnesota, Mississippi, Nebraska, North Dakota, Ohio, Pennsylvania, South Dakota, Vermont, Virginia, Wisconsin, and Wyoming have statutes in force regulating the sale of paints.

Laws of Movement and Determination of Quality of Ground Water. H. Koschmieder. [Gesundheits-Ingenieur, Munich, 46 (1923) No. 5, pp. 49-52, figs. 2.] A mathematical analysis of the subject is given with particular reference to flow into wells.

Our Broadening Knowledge of Lubrication. A. E. Dunstan and F. B. Thole. [Chemical and Metallurgical Engineering, New York, 28 (1923) No. 7, pp. 299-302.] A review is given of recent chemical and physical researches that have brought about a better understanding of the composition and properties of mineral lubricating oils and a program is suggested for future research on the subject.

Theory of the Thresher Cylinder. W. Gorjatschkin. [Technik Landwirtschaft, 3 (1922), No. 7, pp. 151-157, figs. 11.] The mechanics of the thresher cylinder are here reduced to a more or less definite mathematical form on the basis of studies of eleven machines made in a Russian institution before the war.

Testing Oiliness by Friction-Testing Machines. W. H. Herschel. [Chemical and Metallurgical Engineering, New York, 28 (1923) No. 7, pp. 302, 303.] The methods of measuring oiliness of lubricants and analyzing the results used in the U. S. Bureau of Standards are briefly described.

Horse and Power Mowing Costs Compared. [Implement and Machinery Review, London, 48 (1922), No. 574, pp. 1246, 1247. Tabular data comparing horse and power mowing costs are presented, indicating that, while the single mower and the tractor are more economical than the horse outfit, it is substantially cheaper to use two-horse mowers and a tractor or a tractor attachment. These results were obtained with a poor hay crop on a very heavy loam soil.

Diagrams for Submerged Cippoletti Weirs. W. G. Steward. [Reclamation Record (U. S.), 14 (1923) No. 1, pp. 30, 31, figs. 2.] Diagrams for submerged Cippoletti weirs are presented and discussed, which are based on experiments conducted from time to time by the U. S. Reclamation Service.

Seepage from Earth Canals in Texas. W. F. Heath. [Engineering News-Record, New York, 89 (1922), No. 25, p. 1075.] It is stated that tests for seepage and evaporation in one of the canals of the San Benito irrigation district, Texas, indicate that 92 per cent of the total loss is seepage and 8 per cent evaporation. Spread over the whole district these losses amount to nearly one acre-foot per acre. Canal lining and drainage on each side of the canals are suggested, the first to reduce seepage to a minimum and the second to minimize its harmful effects.

Automatic Uncoupling Apparatus for Tractors. R. Dessaisaix. [Journal Agr. Prat., n. ser., Paris, 38 (1922) No. 50, pp. 500-502, figs. 2.] An apparatus is described and diagrammatically illustrated which permits the automatic uncoupling of a tractor from cultivating machinery in cases of sudden overload or rearing of the tractor at time of starting. Its purpose is to prevent accidents due to tractor rearing, killing of the tractor motor, and motor breakage due to sudden overload.

An Experimental Survey of Gasoline and Kerosene Carburetion. C. S. Kegerreis and G. A. Young. [Journal of Society of Automotive Engineers, New York, 12 (1923) No. 1, pp. 63-75, figs. 39.] In a contribution from the engineering experiment station of Purdue University, the results of several investigations on the carburetion of gasoline and kerosene in internal-combustion engines are assembled and considered from various viewpoints, special attention being given to fuel waste. A large amount of graphic data is presented and discussed. The scope of the paper is considered to be too broad for the drawing of general conclusions or for a detailed discussion of any one subject.

Power and Heat in the Dairy Industry. I. Charbonnier. [Technik Landwirtschaft, Berlin, 3 (1922), No. 9, pp. 208-212, fig. 1.] The results of an intensive study of the utilization of power and heat in a German dairy to compare the efficiencies of steam power and central station electrical energy are presented and discussed. Under the present conditions of operation of dairies, central station electrical energy has been found to be considerably more expensive than steam.

Heat Study in a Dairy of the Dahme District (Germany). G. Fischer and R. Gerdes. [Technik Landwirtschaft, Berlin, 3 (1922), No. 6, pp. 125-129, fig. 1.] Comparative trials of steam and electric motor power for performing the different operations in a dairy are briefly described. The electrical method was as a whole more expensive than the steam plant method, although less fuel was required by the electrical method.

Manufacture of Industrial Alcohol and Alcohol Motor Fuel in the Philippine Islands. H. I. Cole. [Philippine Journal of Science, Manila, 21 (1922), No. 1, pp. 17-47, pl. 1, figs. 3; abs. in Chemical Age (New York), 30 (1922), No. 11, pp. 489-492.] Considerable data on the manufacture of alcohol, primarily for use as fuel in internal-combustion engines, are summarized in this paper.

It has been found that nipa palm and molasses offer cheap and easily manipulated sources of alcohol for use as a motor fuel although it is thought that alcohol alone will probably not be used as a motor fuel until a new type of high-compression, slow-speed engine is developed.

Preliminary Note on the Purification of Water by Activated Silt. G. J. Fowler and R. R. Deo. [Journal Indian Institute of Science, Bangalore, South India, 4 (1921), No. 9, pp. 149-157.] Studies on water purification by means of so-called activated silt prepared by wetting, bacterization, and aeration of common river silt are reported.

Laboratory experiments showed that such activated silt is capable of causing the rapid oxidation of dissolved organic matter in polluted water. Further studies showed that the continuous addition of even small quantities of sewage or polluted water to a silt-laden stream tends to hasten silt deposition.

The Most Efficient Source of Power and Heat for the Dairy. I. Charbonnier. [Technik Landwirtschaft, Berlin, 2 (1921), No. 5, pp. 89-94.] An analysis is given of the use of heat and power in German dairies, with particular reference to the comparative efficiencies of local steam plant and central station electrical energy. In this connection data are presented from a direct comparison of the operation of a particular dairy by steam power plant and by central station electricity. This showed that the steam power plant

accomplished about 10 per cent more per unit of fuel used than the central station energy. The conclusion is that steam, especially where waste steam is available, is the logical means for dairy operation.

Experimental Field for Agricultural Hydrology, M. Conti. [Universidad Nacional de la Plata, Revista de la Facultad de Agronomía, published la Plata, 3. ser., 14 (1921), No. 3, pp. 97-121, pl. 1. figs. 8.] A description of the experimental irrigation field of the Universidad Nacional de la Plata is presented, together with a plan of the studies being conducted, analyses of the soils, meteorological data, descriptions of water-measuring devices, and typical results obtained with corn, peanuts, and potatoes. The general plan of the studies includes duty of water experiments, comparisons of methods, amounts, and frequencies of irrigation,and investigations into the effect of mulches and cultivation on water economy. The field is laid off so that dry farming and irrigated farming can be compared directly.

New Jersey Poultry Buildings, W. C. Thompson, W. P. Thorp, Jr., and G. H. Pound. [New Jersey Station Bulletin, New Brunswick, 370 (1923), pp. 56, figs. 39.] This bulletin supersedes a previous one by Thompson and H. R. Lewis, dealing with laying and breeding houses. It summarizes the essential factors and principles to be observed in the planning and construction of poultry houses, and gives the most recent information regarding the New Jersey multiple unit laying house and suburban unit house, incubator cellar, feed house, and the New Jersey multiple brooder house. Trap nests, hoppers, electric lighting, and miscellaneous equipment are also dealt with. Numerous detailed drawings and bills of material are included.

Torsion of Crankshafts, S. Timoshenko. [Mechanical Engineering (New York), 45 (1923), No. 2, pp. 96-98, figs. 4.] This is a mathematical analysis of the case of a crankshaft with a single throw, covering (1) no constraint, corresponding to ample clearance in the bearings, (2) complete constraint, corresponding to no clearance in the bearings, and (3) partial constraint, corresponding to ample clearance in the halves of the bearings nearest the web and no clearance in the other halves.

The analysis brings out the effect of the constraint at the bearings. The more complete it is the stiffer is the shaft and the shorter the reduced length. The calculations further show that an increase in the diameters of journal and pin and increase in the length of the pin cause a reduction of the effect of constraint and of bearing pressures. On the other hand, an increase in the thickness of the web brings about a recommendation of the bearing reactions.

Measurement of Irrigation Water on the Farm, H. A. Wadsworth. [California Station Circular 250 (1922), pp. 36, figs. 17.] Tabular data and formulas necessary for the measurement of irrigation water under the varying conditions found in California are presented and discussed in this circular.

It is stated that common devices for measuring irrigation water in California include rectangular, Cipolletti, and triangular weirs, submerged orifices with fixed and adjustable openings, various miner's-inch boxes and hydrants, and numerous mechanical devices. Weirs are considered to be the most satisfactory for use where the water to be measured is free from silt and where the grade of the ditch is sufficient to allow for the required backing up of the stream. A triangular or V-notch weir is the most accurate for small heads of water and a rectangular for larger heads. A submerged orifice is considered the most satisfactory measuring device if the ditch grade at the required point of measurement is flat, or if the water to be measured is heavily charged with silt.

Soil Physics Investigations at the California Station. (California Station Report 1922, pp. 160.) Studies by E. V. Winterer on the effect of initial treatment of soil on moisture equivalent are said to have shown that the moisture equivalent will vary if samples of the same soil are held at different degrees of moisture for a brief period before making the determination. The structure of the soil is altered by this treatment, and it may afterward undergo air drying, oven drying or pulverizing without restoring the original structure conditions in so far as they affect the moisture equivalent.

Preliminary studies by Winterer and R. E. Storie are said to have shown that the structure of adobe soils is somewhat altered by being cropped to rice. The hygroscopic coefficient and the volume of contraction of the rice soils were lower than adjacent similar soils that were never cropped to rice. Neither the volume weight nor the organic matter content showed any consistent differences, but the pore space of the rice soils was somewhat larger.

Discharge Through Adjustable Submerged Orifices, H. A. Wadsworth. [Engineering News-Record, New York, 90 (1923), No. 7, pp. 308, 309, figs. 6.] Experiments conducted by the University of California and the Colorado Experiment Station, in cooperation with the U. S. Department of Agriculture, to increase the accuracy of the adjustable submerged orifice as a means of measuring irrigation water are described briefly. It was found that the size of the opening of a submerged orifice and the contractions and suppressions are deciding factors in determining the discharge. From the results of the experiments, a new formula was devised, in which $Q = CA\sqrt{2gxH^{0.454}}$. In this formula Q is discharge in cubic feet per second, A is area, and H is the head. Tabular and graphic data of the tests based upon this formula are presented covering a range of discharge of from 0.5 to 13 second-feet and a range of areas of from 0.3 to 3 square feet.

Economic Motor Fuel Volatility, R. E. Carlson. [Journal of Society of Automotive Engineers, New York, 12 (1923), No. 2, pp. 139-150, figs. 14.] This is a report of an investigation made by the U. S. Bureau of Standards to secure data for use as a basis in estimating the effect of a change in gasoline volatility on the fuel consumption of internal-combustion engines now in service throughout the United States. Actual tests begun in 1922 to determine the effect of four fuels of different characteristics on the accomplishment obtainable per gallon of fuel as well as on crankcase oil dilution are described.

It is concluded from these tests that, on the basis of the number of miles per barrel of crude oil, the advantage among the fuels lies with that of lowest volatility when used under summer conditions. It is stated that whether the use of this fuel represents a real economic gain depends on whether its use will result in disadvantages of sufficient magnitude to offset the gain in the number of miles per gallon of crude oil.

Uses of Electrical Energy in Agriculture. [Electrical World, New York, 81 (1923), No. 5, pp. 268-270, figs. 4.] This is a review of a paper presented before the Institution of Electrical Engineers in Great Britain by R. B. Mathews, describing experiences on the uses of electrical energy in agriculture on the European Continent. It is stated that the annual consumption of electricity in farm buildings alone is proportional to the size of the whole farm and averages 10 kilowatt-hours per acre. The probable energy consumption on a well-equipped farm should total 44 kilowatt-hours per acre of arable land for plowing, cultivation, electroculture, silage cutting, harvesting, etc.

From a study of results on the Continent and in England, and from experience in the operation of a 600-acre farm, the conclusion is drawn that the successful solution of the application of electricity to farming is not merely a matter of belting a standard motor to existing machinery. One of the more important problems in this connection is the limited seasonal use of much of the machinery, and the further point is brought out that a large portion of the labor available is prejudiced against and not accustomed to such machinery. It is maintained that an increased efficiency in farming operations in Europe, including circumvention of adverse weather conditions, is obtainable by using electrical energy.

It is stated that milking machines, water pumps, cream separators and other dairy equipment, electric light, electrical stimulation of egg production, incubator heating, household appliances, and other smaller fields for the use of electricity seem to have had about the same consideration as in the United States. Electroculture and the use of electrical energy for the major farm operations have, on the other hand, received greater attention both in England and on the Continent than in the United States. Plowing especially has received considerable attention, and five methods in use are described, including the storage battery method, cable method, electrically hauled plow method, single cable-winding device method, and a so-called roundabout steam system. The first two methods are dismissed as being unsatisfactory, and the opposition to the third or double haulage system is the cost of equipment. A system compromising between the double haulage and so-called roundabout systems is considered to be the most practicable for ordinary farms, and the outlay for the roundabout equipment is said to be reasonable. The power required is from 12 to 60 horsepower.

Everything seems to indicate that the conditions governing the use of electrical energy for farming operations in Europe and the United States are not comparable.

Water Holding Capacity of Irrigated Soils, O. W. Israelsen and F. L. West. [Utah Station Bulletin 183 (1922), pp. 3-24, figs. 7.] Studies on the capacity of soils in the natural field conditions to absorb and retain irrigation water are reported. A review of water capacity measurements made by ten investigators in eight states and on twenty different classes of soil is presented, showing that the amount of water absorbed by the soil when in need of irrigation varied from 0.5 inches of water to one foot of sand soil to 2.25 inches of water to one foot of clay loam soil.

The experimental work was conducted on uncropped plats to which excessive amounts of water were applied, thus assuring complete capillary saturation. It was found that one day after irrigation the plat which received the 36 inches of water held one-third inch more per foot of soil than the plat which was given 12 inches, and that the plat receiving the 24 inches held 0.25 inches more water per foot of soil than the 12-inch plat. Ten days after the heavy irrigations were applied each of the plats held the same amount of available water, about 1.5 inches per foot in the upper 6 feet.

These results are taken to indicate that as a general rule soils have the capacity to absorb from 0.5 to 1.5 inches of water to each foot of depth of soil that needs moistening, and that the actual capacity of a given soil depends upon its texture and structure. Sandy or gravelly soils retain the smaller amounts and clay loam soils the larger amounts.

Spontaneous Combustion in Hay Mows and Stacks, E. P. Heaton, J. E. Ritchie, and C. H. Cowan. (Toronto: Fire Marshall Office. 1921, pp. 43.) The results of investigations of four hundred fires on farms are briefly presented, indicating that the modern bank barn with close siding, frequently battened on the outside, and with inadequate gable and roof ventilation is a contributing cause of spontaneous combustion.

It is concluded that crops such as alfalfa, lucern, alsike, and clovers can not be properly cured and placed in condition to be housed by the same procedure used with crops such as timothy. Crops upon which rain has fallen should not be housed until thoroughly and completely dry, and after being housed no water from rain or otherwise should be permitted to fall thereon. The practice of placing grain in the sheaf, baled hay, and straw above hay mows, compressing the hay and preventing the escape of gas, is considered to encourage very materially so-called spontaneous combustion, and the old-time process of salting hay is considered to be an effective means of retarding combustion. Stacks of hay or straw should never be built upon old footings, particularly when manure has been dumped thereon.

The investigations indicate that the hay loader is frequently used to take up the crop from windrows without cocking or coiling. This practice is considered to be indefensible, and it is stated that speeding up by the aid of machinery necessarily means imperfect curing and invites spontaneous combustion. It is stated that nearly every county in Ontario during the year 1921 had mysterious barn fires occurring between the hours of 6 A. M. and 9:30 P. M., usually in the months immediately following harvesting or threshing.

Agricultural Engineering at the Missouri Station. [Missouri Station Bulletin 197 (1922), pp. 35, 36.] Studies conducted by J. C. Wooley on methods of prolonging the service of wood fence posts are briefly presented. Seven series of treatments were tested. These included setting in gravel without treatment, charring the butts to a height of 36 inches, painting with hot carbolineum to a height of 36 inches, painting with two coats of hot creosote, immersion in boiling creosote for two hours followed by immersion in cold creosote for two hours, and immersion in hot and cold creosote for five hours. The last two treatments gave by far the best results over an eight-year period. Setting the posts in gravel without treatment gave better results than charring the butts and setting in soil, and one coat of hot carbolineum apparently was more effective than two coats of creosote. The common woods tested are divided into four classes of post timber. The first or best class includes white cedar, catalpa, Osage orange, and black locust; the second class the oak, white walnut, and honey locust; the third class black walnut, hickory,

sassafras, black ash, hackberry, the elms, and dogwood; and the fourth class includes the more common soft woods.

Investigations on the cost of cultivating corn with a motor cultivator, by M. M. Jones, showed that the amount of fuel used per acre was 0.735 gallons, the amount of oil 0.1 quart, and the average time required 42.1 minutes.

A study by Wooley on the fuel required for charging a 90-ampere-hour storage battery showed that with gasoline as fuel the cost was 11 cents and with kerosene 4.9 cents per kilowatt-hour. A comparison of a small water tank system with a large storage tank system showed that the former cost about 5 cents and the latter about 2 cents per 100 gallons.

Tests of the draft of wagons by Wooley showed that a four-wheel wagon with load concentrated on the rear wheels gave a slightly lighter draft than one uniformly loaded. The lightest drafts of wagons were obtained on good brick pavements. The low wheel gave the heaviest draft in all cases except on concrete, wet gravel, and macadam. The wheel of medium height gave the heaviest draft on concrete and the high wheel on macadam. The high wheel gave the lightest draft in all cases except on good brick, dry gravel and dry clay, where the medium wheel gave the lightest draft. The low wheel gave the lightest draft on wet gravel. A wide tire gave the heaviest draft on good brick, poor brick, cinders, wet gravel, and burnt clay, and a narrow tire gave the heaviest draft on all other roads.

Cartridge Diameter and Strength of High Explosives, S. P. Howell and J. E. Crewshaw. [Engineering and Contracting, Railways, Chicago, 59 (1923), No. 2, pp. 425-429, figs. 4.] The results of tests conducted by the U. S. Bureau of Mines on the effect of cartridge diameter on strength and sensitiveness of certain high explosives are reported.

These showed that both the rate of detonation and sensitiveness to explosion by influence increased with the increase in diameter of cartridge. Gelatin dynamites rapidly decreased in sensitiveness to detonation and explosion by influence on aging, while ammonia dynamite was very little affected. The insensitiveness of gelatin dynamites to detonation and explosion by influence on aging proceeded more rapidly the smaller the diameter of cartridge. The insensitiveness to detonation and explosion by influence proceeded more rapidly with 60 per cent gelatin dynamite than with 40 per cent gelatin dynamite.

It is concluded that the effect of cartridge diameter is very important in that the more rapid increase in sensitiveness to detonation of the smaller diameter is likely to cause more misfires, while the decrease in sensitiveness to explosion by influence is likely to cause more partial failures from foreign material in the bore hole. An investigation of samples of gelatin dynamites which failed to detonate indicated the great importance of the thorough tamping of gelatin dynamite shots, since the resulting confinement will insure better and more complete detonation. It is generally concluded that both economy and safety in the use of explosives is lost by the use of a ⅞-inch diameter of cartridge, and that every effort should be made to use drill holes of sufficient diameter to accommodate cartridges of not less than 1.25 inches in diameter, especially when using gelatin dynamites.

What the Arlington (Roads) Investigations are Showing, A. T. Goldbeck. [Engineering and Contracting, Roads and Streets, Chicago, 59 (1923), No. 2, pp. 301-312, figs. 13.] The experiments being conducted by the U. S. Department of Agriculture, Bureau of Public Roads, at the Arlington experiment station on the structural design of roads and on the properties of road materials are briefly outlined, and some of the more important results already obtained are summarized.

The investigations of the physical characteristics of sub-grades have indicated that soils having the same mechanical analysis may be entirely different in their bearing values, moisture contents, and volumetric changes, and that the character and quantity of clay in a soil materially affect its ability to adsorb moisture and to retain it under the action of a centrifugal force equal to that of 1000 times the force of gravity. Soils having approximately the same clay content may take up entirely different quantities of capillary moisture due to the character of the clay content.

Studies of the factors of the bearing values of soils, while not conclusive, have indicated that when the moisture index or the ratio of the volume of moisture to the apparent volume of solid content of the soil is less than unity, the bearing value will be high. When the moisture index of the soil is above unity, high bearing values can be obtained provided the adsorption of the soil is high. Soils having a moisture index greater than unity and low adsorptive powers almost invariably have low bearing values. Special tests have shown that the bearing value of the soil having penetrations of the bearing block equal to 0.1 inch varies greatly with the size of the bearing block and that when small bearing areas are used the results are far higher and not at all indicative of the bearing value of the soil for supporting a pavement.

Studies on the treatment of poor subgrades by the admixture of foreign materials have shown that both hydrated lime and Portland cement greatly decreased the volumetric change of a poor soil and very greatly increased the bearing value, so that such admixtures are considered to be decidedly beneficial.

The progress of studies on ten different types of subgrade drainage has indicated that tile drainage will remove water only in excess of capillary moisture, and that a low temperature at the surface accelerates the movement of capillary moisture.

The results of preliminary investigations to determine the static load supporting value of different thicknesses of broken stone base and concrete base, supported on a very wet clay subgrade and on a dry sand subgrade, have shown that with the broken stone base on wet clay the maximum intensity of pressure on the subgrade decreases with the thickness of the base at least until failure has begun. In general, the thicker the base the higher is the load carrying capacity, and the higher can the pressure intensity on the subgrade be before failure takes place.

The results of the impact tests which have been noted from time to time are also reviewed, and new investigations now under way are briefly described.

Internal-Combustion Engine Characteristics Under High Compression, J. H. Holloway, H. A. Huebotter, and G. A. Young. [Journal of Society of Automotive Engineers, New York, 12 (1923), No. 1, pp. 111-117, figs. 11.] The results of a series of studies conducted during the summer of 1922 at the engineering experiment station of Purdue University in the operation of internal-combustion engines under comparatively high compressions on ordinary gasoline without detonation are reported. The compression ratio of the engine used was 6.75 and the compression pressure was 122 pounds per square inch. The ingoing charge was passed through a hot-spot vaporizer and thence through a cooler between the carburetor and the valves. Jacket water temperatures between 150 and 170 degrees Fahrenheit were carried at the outlet port of the jacket.

The results are taken to indicate that automotive engines designed to give a uniform cooling of the combustion chamber walls will permit the use of much higher compression ratios than those employed at present, with a consequent gain in engine power and economy. The fuel-air ratio for maximum economy was found to border upon the lean limit for reliable combustion. For maximum power the mixture ratio need not exceed 0.075 pounds of gasoline per pound of dry air. With concentrated heating of the mixture at the carburetor outlet, a local temperature of 125 degrees was sufficient to give good operation at full throttle. Cooling to 100 degrees at the valves was found to be desirable if the compression pressure of the engine is high. At part loads a hot-spot temperature of 175 degrees with or without intermediate cooling gave good results with lean mixtures.

It is concluded that the power of an engine can be increased 25 per cent by a change in the compression ratio from 4.45 to 6.75, provided detonation is absent. With the same change in the compression ratio, the thermal efficiency is raised from 7 to 12 per cent through a load range of from 25 to 100 per cent of the engine power.

Utilization of Vegetable Oils for Motive Power, Mathot. [Bulletin des Matieres Grasses, Institut Colonial Marseille, No. 7-8 (1922) pp. 116-124.] Tests of four two-stroke-cycle and one four-stroke-cycle engine using palm and cottonseed oils for fuel are reported and discussed.

The results are taken to indicate that semi-Diesel motors of either the two or four-stroke-cycle type may be accommodated perfectly with vegetable oils as fuel. Such fuels are considered to be practical and economical sources of power for colonial requirements in the tropics.

A. S. A. E. and Related Activities

New A. S. A. E. Headquarters

THE Council of the American Society of Agricultural Engineers has approved the change of Society headquarters from St. Joseph to Mt. Clemens, Michigan, which will be effective on and after September 15.

Raymond Olney, in addition to being Secretary and Treasurer of the Society, is editor of "Power Farming," a monthly publication for farmers devoted exclusively to the field of agricultural engineering—a position which he has held since 1915. Recently "Power Farming" was purchased by Mr. George M. Slocum, also publisher of "The Michigan Business Farmer," and will hereafter be published from Detroit. In order for Mr. Olney to retain both connections it became necessary to move the Society headquarters, to which the Council readily gave its approval. While "Power Farming" is to be published from Detroit, Mr. Olney's office and the headquarters of the Society will be located at Mt. Clemens, a suburb of Detroit twenty miles north of the latter city.

The nearness of this location to America's fourth city and the automotive center of the world possesses advantages for the A. S. A. E. headquarters not available at St. Joseph, and not possessed by any other city with the possible exception of Chicago. Mr. Olney's activities on behalf of the Society will continue in the same manner as they have since he took over the duties of secretary nearly two years ago.

Agricultural Engineering Standards Adopted

THE canvass of the letter ballot on standards submitted to the voting membership of the American Society of Agricultural Engineers with the Secretary's letter of April 2, 1923, shows an almost unanimous approval of the standards submitted. These included the standard manger form for dairy barns and the standard litter carrier sizes and capacities sponsored by the Committee on Farm Building Equipment, and the A.S.A.E. Tractor Testing and Rating Code sponsored by the Committee on Tractor Testing and Rating. The recommendations for these standards submitted by the two committees and approved by the Standards Committee were published on page 29 and 30 of the February, 1923, number (Vol. 4, No. 2) of Agricultural Engineering.

The next step in making the Tractor Testing and Rating Code generally acceptable to engineers and manufacturers,

as well as meeting requirements in effect or contemplated in various state regulations, is the consideration, and perhaps minor revisions of the code by a joint conference of representatives of the American Society of Agricultural Engineers, the Society of Automotive Engineers, and the National Association of Farm Equipment Manufacturers. When the recommendations of the joint conference have been approved by the two last named organizations, the membership of the American Society of Agricultural Engineers will be asked to approve any revisions that may have been made. On the final adoption of the code by the three organizations, it will probably be known as the "American Tractor Testing and Rating Code."

Second Annual Meeting of Pacific Coast Engineers

AGRICULTURAL-engineering subjects of interest will be presented at the second annual meeting of the agricultural engineers on the Pacific Coast which is being sponsored by members of the American Society of Agricultural Engineers, which is to be held at Agricultural Hall, University of California, Berkeley, on Friday, October 19. There will be a morning and afternoon session on the campus and a banquet is being arranged for in one of the famous Bay City hotels.

Papers of special interest are being prepared. These include "Application of Electricity to Agriculture in California," by R. C. Griffin, Pacific Gas and Electric Company; "Factors Influencing the Depreciation of Farm Buildings," by C. Harold Hopkins; "The Development of Deep Tillage Machinery in California," by L. J. Fletcher.

There will also be an interesting paper on land settlement presented by a member of the American Society of Agricultural Engineers who has taken a prominent part in California land settlement projects. Papers on irrigation and drainage are also being prepared.

This meeting will not be confined to members of the American Society of Agricultural Engineers, but anyone interested is cordially invited to attend.

For further information concerning this meeting write L. J. Fletcher, agricultural engineering division, Branch College of Agriculture, Davis, California.

New Members of the Society

H. H. Barrows, senior drainage engineer, U. S. Department of Agriculture, 1402 L Street, N. W., Washington, D. C.

Anton E. Jensen, instructor in farm mechanics, department of farm mechanics, Oregon Agricultural College, Corvallis, Oregon.

Transfer of Grade

Robert E. Kreitler, RFD No. 7, Warren, Ohio. (From Student to Junior Member.)

J. H. Stowers, Pine Ridge, Mississippi. (Transfer from Student to Junior Member.)

W. H. Strong, agent, Child Welfare Commission of North Carolina, 630 N. Blount Street, Raleigh, North Carolina.
(Transfer from Student to Junior Member.)

Applicants for Membership

The following is a list of applicants for membership received since the publication of the August issue of Agricultural Engineering. Members of the Society are urged to send pertinent information relative to the applicants for the consideration of the Council prior to election.

Frank Binns, instructor in mechanical drawing and machine design, University of Pennsylvania. RFD No. 3, Hammonton, New Jersey.

Ross Dowell, agricultural engineer, Portland Cement Association. 1021 Polk Blvd., Des Moines, Iowa.

Kurt Grunwald, consulting agricultural engineer, Western address, 926 Equitable Building, Denver, Colorado, Eastern address, Medford, Long Island, New York.

Charles Lee Ostrander, c/o Lichty Metal Products Company, Waterloo, Iowa.

Louie Pickus, repairs department, International Harvester Company, Sioux City, Iowa. (Transfer from Student to Junior Member.)

EMPLOYMENT SERVICE

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of Agricultural Engineering. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Non-members, as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

MECHANICAL AND ELECTRICAL ENGINEER, graduate of Cornell University and Armour Institute, with nineteen years of practical experience in designing, manufacturing, and marketing gasoline engines, automobiles, motor trucks, and tractors, having specialized particularly on internal-combustion motors and their application, prefers mechanical work cooperating with the different manufacturing and sales departments along the lines of sales engineering, or other work into which his qualifications would fit. MA-104

AGRICULTURAL ENGINEER wants position in southwest. Graduate of University of Illinois 1915, five years practical experience on Illinois farm with power equipment, two years in charge of the agricultural engineering department New Mexico College of Agriculture; considerable garage experience and service experience on unit power and light plants. Also one summer in Philadelphia battery service station. MA-106

AGRICULTURAL ENGINEER, graduating from Iowa State College June 10, 1923, would like position with some company or individual engaged in drainage or irrigation work. Five years' practical farm experience. MA-118.

GRADUATE AGRICULTURAL ENGINEER, now employed by tractor company, wishes position teaching agricultural engineering work. Will be available in summer or to start next fall. MA-115.

AGRICULTURAL ENGINEER, graduating from University of Illinois at end of present semester (available March 1, 1923) would like position in service department or experimental department of company manufacturing tractors or farm machinery. Three years' practical farm experience in West and one year in Illinois. Age 27. Unmarried. MA-116

DEVELOPMENT AND RESEARCH ENGINEER, technical graduate, inventive ability, practical, experienced in the development, design, manufacture, and distribution of farm machinery. Can carry through from the embryo idea, through development stages, production in manufacturing, and marketing. Age 29. Married. Excellent character. Available immediately. MA-117.

AGRICULTURAL ENGINEER wants position about November 1 in teaching, sales, or experimental work along agricultural engineering lines. Have B. S. A. degree University of Minnesota; Minnesota gas and steam engineer certificate; took Dunwoody general machine shop course and a business college course. Experiences are army officer, instructor in three universities in agricultural engineering, owner of motorized farm, and owner of Ford garage and power and farm machinery business at present. At present studying Alexander Hamilton course. Member American Society of Agricultural Engineers, and a Mason. Would consider foreign service. MA-119.

Positions Open

DRAFTSMAN who has had experience in designing and manufacturing threshing machinery with reliable, well-established farm-machinery manufacturer in central Pennsylvania. PO-1.

STUDENT FELLOW IN AGRICULTURAL ENGINEERING. There will be an opening beginning September, 1923, for a student fellow in agricultural engineering at the Virginia Polytechnic Institute. Write Charles E. Seitz, department of agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Virginia. PO-4.

INSTRUCTOR IN AGRICULTURAL ENGINEERING. The department of agricultural engineering of the Virginia Polytechnic Institute has an opening for an instructor to handle farm surveying, farm buildings, farm concrete, and rural architecture. He will also devote part time to extension work. Write Charles E. Seitz, department of agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Virginia. PO-5.

INSTRUCTOR IN AGRICULTURAL ENGINEERING. The department of agricultural engineering, Macdonald College, will have an opening beginning September 1 for an instructor in farm machinery, concrete work, farm sanitation, carpentry and drainage. Write L. G. Heimpel, Department of Agricultural Engineering, Macdonald College, P. Que., Canada. PO-6.

INSTRUCTOR IN FARM SHOP WORK and to carry on outside investigation along this line wanted by an agricultural college in the South. Salary $2250 to $2500. Ranking will be assistant or associate professor according to qualifications. PO-7.

EXTENSION AGRICULTURAL ENGINEER wanted immediately. Man with experience required. Salary according to training and experience. Write University of Nebraska, Lincoln, giving qualifications and references. Also state minimum salary. PO-8.

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Directory of Professional Agricultural Engineers